DOCUMENT RESUME

ED 214 138 CS 006 557

AUTHOR Gima, Shinye
TITLE The Effects of Word Potency, Frequency, and Graphic Characteristics on Word Recognition in the Parafoveal Field.
PUB DATE Mar 82
NOTE 67p.; Paper presented at the Annual Meeting of the American Educational Research Association (New York, NY, March 19-23, 1982).

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Cognitive Processes; College Students; Eye Movements; Eyes; Higher Education; Learning Theories; Reading Processes; *Reading Research; Tachistoscopes; *Visual Perception; *Word Frequency; *Word Recognition
IDENTIFIERS *Eye Structure; *Word Potency

ABSTRACT

A study investigated the theory that the affective dimension of words can have a significant effect on the process of word recognition. Specifically, the study examined whether word potency (the emotional impact of a word), frequency, and certain graphic characteristics affected word recognition in the parafoveal field under very brief exposure conditions. High potency words were paired with neutral words (1) matched in frequency, word length, and graphic considerations, (2) separated by six spaces, and (3) presented on tachistoscopes to the subjects at exposures too brief for eye movements to occur. Subjects, 92 college students, were assigned to either a control group that saw word pairs of neutral words only, or to an experimental group that saw word pairs with potent words and neutral words. The results showed that word potency was a significant variable, but that under the experimental conditions of brief exposures and parafoveal location, graphic considerations were also significant variables in word recognition. (FL)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED214138

THE EFFECTS OF WORD POTENCY, FREQUENCY, AND GRAPHIC CHARACTERISTICS ON WORD RECOGNITION IN THE PARAFOVEAL FIELD

by

Shinye Gima

Dept. of Educational Communications
and Technology
University of Hawaii

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Shinye Gima

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Paper presented at 1982 Annual Meeting
American Educational Research Association
New York March 19-23, 1982

CS006557

TABLE OF CONTENTS

		Page
I.	INTRODUCTION	1
II.	REVIEW OF THE LITERATURE	3
III.	STATEMENT OF THE PROBLEM	34
IV.	MATERIALS AND METHOD	36
V.	RESULTS	43
VI.	DISCUSSION	51
	REFERENCES	55
	REFERENCE NOTES	63
	LIST OF TABLES	64

THE EFFECTS OF WORD POTENCY, FREQUENCY, AND GRAPHIC CHARACTERISTICS ON WORD RECOGNITION IN THE PARAFOVEAL FIELD

CHAPTER I. INTRODUCTION

The reading process has long been of interest to psychological theorists, researchers, and educators. It was not until the late 19th Century, however, that investigators such as Cattell, and Erdmann and Dodge pioneered in establishing research in reading as a legitimate field of experimental psychology. The subsequent rise of Behaviorism helped turn the mainstream of American psychology "from the study of cognition to learning, from human to animal experimentation, and from purposive to mechanistic explanation" (Geyer & Kolers, 1974, p. 2).

In recent decades, however, there has been a renewed interest in cognitive processes. Neisser (1967) defined cognitive psychology as referring "to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used" (p. 4). The prime cognitive nature of the reading process has caused it to receive much attention by psychologists. "(Much) of the current research with linguistic material done by experimental psychologists is treated explicitly or implicitly as being relevant to the reading process" (Haber, 1978, p. 47).

Along with the resurgence of cognitive psychology, there has been a concurrent development of the information-processing approach, as a method of studying and theorizing about cognitive processes (Estes, 1978). While there have been a few attempts to develop complete models by information-processing theorists, most studies have focused on sub-components of the reading process.

Reading has been characterized as "a complex acquisition comprised of many prerequisite behavioral skills and activities" (Schiffman, 1972, p. 590). Kolers (1970) concluded that there are at least three different stages of competence shown by the skilled reader: (a) the perceptual operations that result in letter and word recognition, (b) a sensitivity to the syntactic relationships between words in text, and (c) the imposition and manipulation of meanings.

This paper deals with the first of the above stages of competence, specifically, the perceptual operations involved in word recognition. The validity of research involving non-contextual single-word perception has been questioned (e.g., Haber, 1978), but, on the other hand, it has been defended as having a valuable role in the broad spectrum of reading research (e.g., Gibson and Levine, 1975; Johnson, 1977; Massaro, 1975(a); Postman and Rosenzweig, 1957).

While "word recognition" in Koler's (1970) sense essentially refers to a broad competency, one among a group of competencies that altogether characterize skilled reading, the concern of this paper was with a narrowly-defined process of word recognition. The experiment described here investigated responses to word stimuli, presented in pairs, under tachistoscopic conditions. The parameters for investigation were (a) the differential effects of single-word stimuli classified according to word potency, frequency and graphical characteristics, (b) presented at very brief exposures, and (c) at varying spatial conditions.

CHAPTER II. REVIEW OF THE LITERATURE

The reading act, as a manifestation of complex human behavior, has been investigated from different perspectives, e.g., as a language process, a psychological process, a physiological process, etc. The emerging contemporary view, however, is one that acknowledges the limitations of specialized approaches and the advantages of integrative research in the reading processes (Geyer and Kolers, 1974; Haber, 1978). Thus, even within the narrow confines of the topic of this paper, i.e., word recognition in the peripheral field, much relevant research has been reported from a diversity of specializations. This review will attemtp to sift evidence from a range of literature representing several fields that overlap or are contiguous. Topics for review are: (a) general information-processing models, (b) models of word recognition, (c) variables in word recognition studies, and (d) studies of word perception in the peripheral field.

General Models of Information-Processing

The usefulness of the information-processing approach in reading research has been discussed by several reviewers (e.g., Estes, 1978; Geyer, 1972; Haber, 1969; Massaro, 1975(a)). It provides a useful basis for analyzing research in reading and its component or related processes. Different models of those processes generally depict the information flow involved: (a) the extraction and transformation of the information, (b) the identification of the processing systems and operational characteristics, and (c) the neurological substrates (Geyer, 1972). Massaro (1975(a)) described the essential processing that takes place between the onset of the stimulus and response thusly:

> A stimulus has potential information and its presentation initiates a sequence of processing stages in which each stage operates on the information available to it. The operations of a particular stage takes time and transforms the information in some way, making the transformed information available to the following stage of processing (pp. 19-20).

Haber (1969) noted that the continuity of different levels of processing involved is a fundamental assumption for the rationale of the information-processing approach.

> Sensation, perception, memory, and thought must be considered on a continuum of cognitive activity. They are mutually interdependent... Further, to understand how these processes function and interact, they should be subjected to an information-processing analysis, rather than be viewed as static structural systems (p.1).

A critical component in information-processing studies has been the function of attention. Broadbent (1958) was the first influential writer to characterize cognitive processes in terms of information-processing and selective attention. His model had three main components: a limited capacity central processor, a selective filter, and a short-term memory. Briefly, in this model, the sensory system fed information into a short-term store, from which a selective filter allowed only the most relevant signals to be further transferred through a limited capacity channel to long-term memory and a response.

Broadbent's Filter Theory has generated much research in information-processing. Treisman (1964) proposed an important revision, in response to findings that under certain conditions meaningful content in the presumably ignored signals do make an impression (Moray, 1969; Treisman, 1964). Treisman's revision was a "filter-attenuation" model in which the filter modulates rather than blocks incoming signals, thus allowing for meaningful material in ignored channels to be attended.

A model of selective attention that was radically different from Broadbent's filter model was the Deutsch and Deutsch (1963) model. Briefly, the Deutsch

and Deutsch model proposed that (a) sensory inputs are processed by (b) stimulus analyzing mechanisms in (c) long-term memory for weighting for their "levels" of importance, on the basis of which (d) selection and attention for further processing, e.g., a response, is made.

The locus of selective attention, whether "early" or "late" in the continuum, has been a primary theoretical issue in information-processing research (Shiffrin, 1975). Shiffrin categorized three types of information-processing models with the theorized location of selective attention in each model. Model A, the Broadbent filter theory type, assumes that information is passed on to the recognition system (in short-term memory) through a single channel at a time. The attention mechanism, the filter, operates at an early stage in this type of model. Model B, Treisman's attenutation type, has limited capacity, but allows some simultaneously processed input from several channels. These models assume a "pre-attention" stage, a kind of preliminary scanning of the periphery to pick up important areas for further, focused attention. Model C, is the "non-attention", independent channels type. All input are processed with no selection operating during processing. All attentional effects are located in short-term store, thus late in the processing continuum.

Since Broadbent's (1958) filter model was first proposed, many different information-processing models have been advanced in the literature. The Treisman (1964) model and the Deutsch and Deutsch (1963) model have been discussed briefly. Other selected models will be mentioned for their relevance to theoretical considerations of this paper, viz., the role of selective attention in word recognition.

The Atkinson and Shiffrin (1968) model postulated two characteristic information-processing features of all phases of memory: (a) permanent

structural features and (b) transient control processes. Set, expectations and prior experience determine control processes, i.e., influence what will be attended.

Waugh and Norman (1965) theorized a model with a dual memory system: A "primary memory" and a "secondary memory". Norman (1969) compressed the dual system into a single-storage system with two levels of analysis possible in that store. Two assumptions provided the basis for the selective attention mechanisms. First, incoming sensory signals activate their representation in memory. Second, a process of selection takes place; contextual, grammatical, meaningful and physical cues are evaluated for the "pertinence" to the situation. The sound of one's own name is an example of an input with high "pertinence". Thus, a combination of levels of pertinence and stimulus properties will determine what will be selected for further processing.

Chase (1978), in a review of human information processing, referred to a "second generation" of models. Chase compared Haber and Hershenson's (1973) model to the 1958 Broadbent model. The differences noted were seen as consequences of the vast amounts of research that have been done since Broadbent's 1958 model, and their influence on development of more recent theoretical views. Chase noted (a) that Broadbent's limited-capacity channel had disappeared and been replaced by short-term memory in central structure, (b) a proliferation of peripheral "memories", i.e., "brief" visual and auditory stages; "visual" and "auditory" images, reflecting the work done by Sperling and others in this area, and (c) long-term memory is now brought much closer to short-term memory. Chase went on to predict that, given the current research trends in semantic memory, the next generation of information-flow models would place long-term memory as the central structure.

Iconic Memory

While the foregoing section has dealt with large-scale, over-arching models of information-processing, this section is focused on a limited portion of the continuum, the early perceptual stages, covering short-term visual images and their interaction with memory. These stages are relevant to this paper since the experiment reported here involved word recognition under brief exposure conditions. One of the theorized stages is "iconic memory" (as Neisser, 1967, labeled it), a short-lived visual representation of the stimulus.

Sperling (1960) reported a study on perception of letters under brief tachistoscopic exposures. Using the technique of partial-report, his subjects were able to give more accurate estimates of the information available for recall than was possible under the full-report technique. He theorized the existence of a very brief "visual image" as a stage in the information-processing of the stimulus display. He estimated that it lasted for a fraction of a second to several seconds.

Sperling's (1960) study led to other investigations and building of models on the early stages of information-processing. Sperling's (1967) model is briefly described here. The components of the model include a visual-information store, which follows the sensory input stage and briefly stores the resulting visual information. Next is a scan component that determines the sequence of locations from which information is fed into the cognition buffer-memory. Here the visual image is encoded into a "program of motor-instructions". For rehearsal purposes, Sperling postulated an auditory storage, which received and temporarily held the motor-instruction program. A feedback loop enabled continuing rehearsal to take place until a response was made.

Iconic memory, i.e., the "visual information store" in Sperling's (1967) model, can be described generally as a large-capacity, short-duration image that

is located in central memory, rather than in the retina, and holds material in a fairly literal form (Dick, 1974). Coltheart (1972) characterized the level of information in the iconic memory as precategorical, i.e., a low-order form of visual information, in which no differentiation has yet been made between "categories" of the information, e.g., between digits and letters.

However, Coltheart (1980) reviewed the literature on iconic memory from the standpoint of iconic memory as (a) "neural persistence", (b) "visible persistence", and (c) "informational persistence". These forms of visual persistence are widely assumed to reflect aspects of a single, underlying process. Coltheart theorized that this assumption is incorrect, that in addition to neural persistence processes manifest in the lower neural system, which gives rise to visible persistence in iconic memory, there is a neural locus which is cortical. Coltheart proposed a mechanism that can coordinate the sensory information and the more lasting semantic associations of an item in iconic memory, viz., a "lexical monitor". This mechanism enables the identity of an item to be stored rapidly, while physical attributes are processed with more difficulty. Thus, he proposed an alternative to the general view of iconic memory as being precategorical. Coltheart's (1980) alternative view is that iconic memory is post-categorical, occuring after stimulus identification.

Erwin (1976) similarly argued for a "processing model" of iconic memory: "The concept of visual persistence which maintains that the operating characteristics of the storage process responsible for maintaining the persisting representation reflect the organization and structure of postsensory processes" (p. 660-661).

Masking has been used as a technique to study various aspects of early stages of perception. This topic has been reviewed extensively (e.g., Breitmeyer and Ganz, 1976; Kahneman, 1968; Turvey, 1973).

Visibility of a briefly exposed stimulus (target) can be affected by another stimulus (mask). Masking can be accomplished in several ways. The target and mask may be concurrently displayed. More useful techniques involve the use of "pattern" or "visual noise" masks that are displayed before (forward masking) or after (backward masking) the target display. "Such methods are especially interesting because they can be employed to probe the spatiotemporal properties of information processing and, in particular, pattern-forming operations in the visual system" (Breitmeyer and Ganz, 1976, p. 1).

Turvey (1973) distinguished between peripheral (lower portions of the system, e.g., the retina) and central locations to explain the masking effect. Peripheral masking involves integration within monocular, but not dichoptic, visual pathways. Central masking depends upon interruption of target processing and occurs dichoptically. Coltheart (1980) theorized that the after-coming pattern mask "preempts the activities of the lexical monitor" (p. 224), which presumably interrupts the processing.

Models of Word Recognition

Since Cattell's experiments in the 1880's on word perception, research in this area has grown tremendously. And yet, it has been remarked that many of the issues that Cattell addressed are still of concern today. An issue relevant to this paper is the specfication of the temporal relation of the levels of processing in word recognition theories. Theios and Muise (1977) reviewed different models of information-processing relative to their approaches to the issue above.

Theios and Muise (1977) classified several current models of reading according to their perspectives on the word recognition process. Those that imply serial, level-by-level processing were the models of Gough (1972);

LaBerge and Samuels (1974); and Smith and Spoehr (1974). Models identified as reflecting a direct memory process of a strictly parallel processing system were those of Anderson (1977); Rumelhart and Siple (1974); and Smith (1971). Turvey (1973) suggested a mixed model, with parallel processing concurrently feeding information into a decision net mechanism which interprets the continuously growing information matrix. Estes' (1975) and Massaro's (1975 (b)) models were thought to fall into this concurrent-contingent type of classification.

Theios and Muise (1977) stated that there appears to be fairly good agreement among theorists as to the main outlines of the word identification process, that it is a hierarchical, level-by-level progression. According to this general model, stimulus input is initially transformed into a visual representation (an icon). A detection response is presumed to be occurring in the observer at this stage of level. Feature analysis is carried out at the next level. There seems to be agreement among theorists that the features of the visual display are processed in parallel. An exception to the parallel-processing view was Gough (1972), who theorized that information was read out letter-by-letter at a rate of 10 to 20 milliseconds per character. Most of the models assumed a parallel-processing operation as described by Theios and Muise:

> In contrast to a serial read-out from iconic memory, most theorists assume that the feature analysis process is carried on in parallel, simultaneously for each character in the display. The icon is assumed to energize a set of feature detectors and the unique pattern of activated features is assumed to map onto or excite letter codes stored in long-term memory. During the feature analysis process the observer should be in a position to make quick discrimination on the basis of such cues as direction, length, angularity, and curvedness (p. 290-91).

The Theios and Muise (1977 model, while admittedly in a conjectural stage, does appear to provide a framework for a word recognition process which would involve a direct semantic identification of a stimulus.

Anderson (1977) proposed a neural model of word recognition, in which he postulated a parallel, distributive memory which would allow for rapid, simultaneous access to all parts of memory. Memory was seen as a complex filter, in which an input may result in large associated outputs, or little, depending on past history. Retrieval time depended on familiarity ("strength") of the item.

Variables in Word Recognition Studies

Gibson and Levin (1975), in reviewing the variables in word perception studies, characterized the word as a complex of features, a composite representation of five classes of information: graphic, phonological, orthographic, semantic and syntactic. Other variables manipulated in word recognition experiments were identified: frequency, familiarity and subject "expectations". Overall, the variables were categorized as objective or subjective. This section of the review is generally organized in the manner of the Gibson and Levin outline above.

Graphic Features

Reading involves visual processing of language signs, i.e., configurations of letters combined into a word. In the reading process, the reader is assumed to utilize the potential cues available in the graphic stimuli to make a letter or word identification (Bouma, 1973; Dunn-Rankin, 1978).

A variety of graphic features have been investigated: type font, word shape, word length, letter position, and features of individual letters. While different type-styles do not appear to play a major role in legibility (Tinker, 1965), upper- and lower-case type has been seen to play a role in reading (Tinker, 1955). Regarding isolated lower-case letters, Bouma (1971) developed confusion matrices which reflected the relative degrees of perceptual similarities among certain groupings. Dunn-Rankin (1968) identified lower-case groupings based on similarity estimates, derived from paired comparisons: (e,a,s,c,o),

(t,l,f,k,i,h), (p,b,d), and (n,u,m,w). Bouma (1971) saw these groupings as closely conforming to his own confusability groupings.

Intraword Redundancy

Intraword redundancy, i.e., cues such as orthographic and syllabication rules, have been investigated regarding their facilitative nature in word perception. Gibson, Pick, Osser, and Hammond (1962) found that skilled readers are more apt to perceive correctly letter strings which follow the rules of English orthography and spelling-to-sound correspondences. For example, GLURCK was seen more often and quickly than CKURGL. Experiments in tachistoscopic recognition of strings of letters with varying approximations to English words lend support to the view that word perception is facilitated by sequential dependencies of letters within the word (Miller, Bruner, and Postman, 1954). A study by Gibson, Osser, and Pick (1963) demonstrated similar results for first- and third-grade children, suggesting that a child in the early stages of reading skill reads in short units, but is already beginning to generalize certain regularties of spelling and spelling-to-sound correspondences. Rumelhart (1976) also cited evidence for the positive effect of orthographic structure on the perception of letter in an orthographically regular string, even to seeing orthographically irregular strings as being regular.

Syllabication is another variable providing intraword redundancy. Spoehr and Smith (1973) investigated the role of syllables in word processing. They concluded that the correct higher-order unit within the word was not the syllable per se, but a "vocalic center group".

Syntactic Characteristics

Rumelhart (1976) stated that the "best evidence" for syntactic effects on word perception lies in the analyses of reading errors, i.e., substitution errors. Reasoning that if syntax had no effect on word perception, it could be expected

that reading errors would be determined by visual similarity and not by part of speech. However, there is a strong tendency for a reading error to be of the same part of speech as the original word (Kolers, 1970). Weber (1970) analyzed reading errors by first graders and found that 91% of the errors made were grammatically acceptable to the preceding context. Rumelhart (1976) cited a study by Stevens and Rumelhart (1975) in which adult readers in an oral reading task made substitution errors, 80% of which were in the same syntactic class as the class most frequently predicted at that part of a close-type task.

Schlosberg (1965) reported on a study comparing relative effectiveness of recognition of nouns and verbs. His method consisted of presenting three short words in sequence, varying the interstimulus interval. Nouns had the advantage over verbs when they were presented first in the sequence, while verbs had the advantage over nouns when presented second. Schlosberg interpreted the interaction of parts of speech with position as due to expectation of sequence of parts of speech in a typical sentence, viz., noun followed by a verb. This suggests that helpful redundancies of syntax operate mainly over unit larger than the word.

Gibson and Guinet (1971) found that inflections of a word, in this case verb tense, affected recognition, though not in the sense of lowering threshold. Inflectional word endings tend to be processed as unitary word features, this effect increasing with the development of reading skill. Inflectional endings can therefore serve as clues to structure of a phrase or a sentence, thus adding more information to the word.

Word Frequency and Familiarity

Word frequency consistently has been shown to be a contributing factor in word recognition studies (e.g., Howes & Solomon, 1951; King-Ellison & Jenkins, 1954; Solomon & Postman, 1952). Sources of word frequency indexes have been

the Thorndike-Lorge count (Thorndike & Lorge, 1944); American Heritage Word Frequency (Carroll, Davies & Richman, 1971); and the Kučera-Francis count (Kučera & Francis, 1970).

The effect of word frequency on word recognition has often been ascribed to response bias, the subject's tendency to guess when perception is inadequate or when there is no stimulus at all (Goldiamond & Hawkins, 1958). In experiments where subjects have partial information presented, recognition was seen to be strongly influenced by their verbal habits (Postman & Rosenzweig, 1957). Response bias in word recognition could be attributed to the familiarity of the stimulus to the subject. Postman and Rosenzweig (1957) wrote that "The speed with which a particular item is recognized depends on the frequency with which this item has been discriminated and used in the past" (p. 253). Avant and Lyman (1975) found that familiarity with letters, words, and non-words generated differential effects in the apparent duration of the stimulus at brief exposures. The word frequency issue is discussed further in the section on affective aspects of word perception.

Semantic Characteristics

Semantic characteristics, as variables in word recognition, have been studied for their effects at different stages of the word recognition process, i.e., sensory perception, storage and retrieval. Research to be reviewed will be organized under the following topics: salience of the word; effects of meaningfulness; storage and retrieval from memory; and affective aspects.

Osgood (Osgood and Hoosain, 1974) has argued that the word has "special status as a psycholinguistic unit, simultaneously being the largest characteristic unit at the meaningless sensory integration level and the smallest characteristic unit at the meaningful representational level" (p. 168). Experiments were reported to demonstrate that "meaningfulness of units as wholes is the critical

determinants of perceptual salience" (p. 187). Meaningful units were defined as words and nominal compounds (e.g., STUMBLING BLOCK) as compared to nonword morphemes and ordinary two-word compounds (e.g., RUSTY BLOCK). The authors argued that this salience is due to two properties, derived from a two-level behavior theory: first, that words maximize the presence of "redundancy as Gestalt-like wholes in perceptual experience; second, that the perception of (words) is facilitated by distinctive feedback from its representational (meaning) level" (p. 169).

The word-superiority effect has provided another kind of evidence for the special role of the word in its facilitative effect on letter recognition within the word (Reicher, 1969; Wheeler, 1970).

Meaningfulness has been studied as a factor in word recognition. Gibson, Bishop, Schiff, and Smith (1964) carried out a study to separate referential meaning from pronounceability in a test of recognition. Stimuli consisted of three categories of trigrams: (a) items with semantic references (initials), (b) a pronounceable item with no referential meaning, and (c) an item that was unpronounceable and also meaningless. They found perceptual thresholds were significantly lower for both the pronounceable and meaningful items than for the control items. Retention was best for the meaningful items.

Henderson (1974), however, pointed out that the Gibson et al. study may have been biased in favor of pronounceability since all the pronounceable trigrams had a central vowel which may provide redundancy (e.g., BIG, MIB, TAW). In his study, Henderson provided further evidence that meaning affects recognition without the help of orthographic structure. In a same-different judgment task, meaningful but unpronounceable letter strings (e.g., UK, LSD, YMCA) were compared faster than meaningless controls. Meaningfulness was a significant variable in reducing reaction time, an effect obtained without the help of orthographic

regularities. Henderson concluded that "an appeal to meaningfulness implies access to the lexicon which may be faster than grapheme-by-grapheme analysis" (p. 308).

Barron and Pittenger (1974) in a same-different task to compare reaction time found significant differences for "same" judgments, with real words faster than pseudowords, and legal nonwords faster than illegal words. They explained their findings thusly:

> (Familiarity) influences "same" judgments because a comparison process is able to efficiently use the higher order semantic and orthographic information available in real and pseudowords. Nonwords are slower because they lack higher-order information which would allow them to be compared as a unit, hence comparison must be carried out using individual letters (graphemic information) (pp. 577-578).

Manelis (1974) also found a clear superiority of words over pronounceable nonwords in forced-choice tachistoscopic recognition of words. Findings were interpreted to support the notion that words, which are represented in lexical memory, are perceived more accurately than structurally matched nonwords, which have no lexical entries.

Henderson and Chard (1978) had subjects search through lists for single target words. Search was faster when the target word belonged to a different semantic category from that of the background words.

Experiments in word recognition based on information-processing models have been done to investigate the relationship of semantic characteristics and the encoding operation in different stages. Baron (1978), in a review, argued that there are different codes that can be activated as the result of an observed stimulus. For example, in a tachistoscopic task, features, letters, and lexical (word) codes may be brough into play. Under brief exposure conditions, it is advantageous to have some kind of code available before the stimulus disappears. Feature and letter-identity codes may be destroyed by the offset

of the stimulus and it would be necessary to have formed higher level codes by that time. Thus, tasks that take their output from lexical codes show word-specific effects (as well as effects of phonemic similarity). In an earlier paper, Baron (1977) discussed the evidence for the mechanism of word recognition that involves activation of a semantic code directly from a letter or spelling pattern code.

Novick (1974) addressed the problem of preprocessing of a stimuli for its phonological lawfulness and its relation to memory search. A parallel process model, which assumes that phonological and meaning search are processed simultaneously, was supported. He concluded that his data demonstrated that subjects were able "to analyze the meaning of the stimulus without first evaluating the phonological properties" (p. 1020).

Hasher and Zacks (1979) argued that "(There) are a number of lines of evidence in the experimental literature that support the contention that word meanings are automatically activated" (p. 376). They cited studies such as Corteen and Wood (1972) and Underwood (1977). The Stroop phenomenon was also cited, i.e., that the inability to inhibit the interfering naming response strongly indicates that the meaning activation process is automatic (Posner and Snyder, 1975).

Kleiman (1975) proposed a dual-retrieval model, in which better readers are able to access meanings directly from the visual encoding, without the necessity of speech recoding.

Meyer, Schvaneveldt, and Ruddy (1975), in a reaction time experiment, found that lexical decisions were made faster to words preceded by an associated word (e.g., BREAD-BUTTER), than to words preceded by an unassociated word (e.g., BREAD-DOCTOR). The contextual effect was explained by a spreading-activation model of retrieval (Schvaneveldt and Meyer, 1973), in which (a) words are stored

in different locations in lexical memory, and (b) accessing information from a particular memory location results in residual neural activity that spreads.

Wickens (1972) defined word meaning as a "bundle of attributes"; final word meaning results from encoding along a number of dimensions. This idea was traced to the theory of Osgood (Osgood, Suci, & Tannenbaum, 1957), which stated that certain classes of word meaning could be represented by a point in three-dimensional space. The axes of the space were the three characteristics of Evaluation, Potency, and Activity. Wickens (1972) studied the following implications from the above characterization of word meaning: (a) psychologically prominent attributes of words can be identified, (b) most words have multiple-component values, and (c) there exist component values independent of the word itself, i.e., that a dimension of the word may be encoded before the name of the word is identified.

Affective Characteristics

The affective characteristics of word perception has been the subject of a vast amount of research, especially within the rubric of the New Look psychology. Erdelyi (1974) gave an estimate of over 1,000 research publications on the New Look topics, since the late 1940's when the first reports were published. Up to then, form perception was dominated by the Old Look Gestalt theories, which emphasized the stimulus rather than the observer, whose perceptions were seen as dependent on inner states (Pierce, 1963). Several reviews of the New Look literature have appeared (e.g., Erdelyi, 1974; Minard, 1965; Pierce, 1963).

Several major assumptions undergirded the New Look psychology. One was the importance of adaptive regulative functions, including that of perception. Executive control processes in the regulation and modification of inputs and memory traces reiterated a strong organismic outlook. Consistent with the above

was the concern with the selectivity and organization of perception as a function of subject needs, expectations, priorities, and psychodynamic defenses (Erdelyi, 1974).

A key paper, which generated much subsequent research, was the work by Postman, Bruner, and McGinnies (1948) entitled "Personal values as selective factors in perception". The authors tested the hypothesis that "personal values are demonstrable determinants of what the individual selects perceptually from his environment" (p. 143). Measures on the Allport-Vernon (1931) Study of Values scale were compared with subjects' recognition thresholds for tachistoscopically presented words which represented each of the scale value areas. They concluded that the higher the value represented by a word, the more rapidly it is likely to be recognized. From the obtained relationship between values and visible duration thresholds, Postman et al. concluded that there were two perceptual processes in operation: perceptual selectivity and perceptual defense.

Other studies with noxious of sexual words as stimuli provided more evidence for the perceptual defense effect. Newton (1955) found significantly fewer errors of recognition for pleasant as compared to unpleasant words, equated for frequency, under tachistoscopic conditions.

McGinnies (1949) found that subjects responded with higher GSR measures to "emotionally loaded" words (e.g., raped, whore, penis) at threshold exposures. In addition, subjects displayed significantly higher thresholds of recognition for the critical than for the neutral words. Weiner (1955) presented double entendre words (e.g., fairy, pussy, balls, screw) in two conditions: a sexually connoting list vs. a nonsexual list, and found differences in response. Manning and Julian (1975) conducted a three-trial learning study to clarify relationships between emotional content of words and recall. Stimuli were upsetting words in categories of sex, bathroom and violence matched to neutral

words also in categories. Results showed better learning for emotional words, especially sex (e.g., fuck, penis, intercourse) and bathroom (e.g., shit, toilet, piss), while the violence category (e.g., war, murder, rape) had effects similar to the neutral words. Dunn-Rankin, Abe-Sullivan, Gima, Hirata, and Loui (1979) found that subject reported recognition of more emotional words in the peripheral field under brief exposure conditions. In a related study, Gima (1979) found that the same adult subjects in the Dunn-Rankin et al. study, rated the emotional words as significantly more "potent" than the other words.

On the other hand, Bitterman and Kniffin (1953) found no significant relationship between anxiety level and recognition threshold for taboo and neutral words in women subjects. The authors concluded that the obtained significant difference between neutral and taboo words in their study can be explained in terms of differential readiness to report than in terms of perceptual distortion.

Arguments were advanced for a unified explanation for both perceptual selectivity (also dubbed "vigilance") and perceptual defense as response to emotional stimuli. Dulany (1957) argued that a readiness to recognize affective words is the really important form of perceptual defense. Frankman and Adams (1962) advanced the idea of the importance of vigilance in the explanation of stimulus detection. An integrated view of perceptual defense and vigilane interpretations was put forth by Minard (1965), based on reviews of work by Bruner and Postman (1947), Brown (1961), and Inglis (1961). A U-shaped curve was seen as the correct description of this unified relationship between threshold and stimulus affectivity.

Howes and Solomon (1951) objected to the concept of perceptual defense. They argued that the Postman et al. (1948) findings could be accounted for by the effect of word frequency. They found that the visual duration threshold

of a word, measured tachistoscopically by an ascending method of limits, is an approximately linear function of the logarithmic relative frequency, as measured by the Thorndike-Lorge count. This raised the question whether or not the effect of personal values on perceptual sensitivity to words can be fully accounted for in terms of the relative familiarity of the stimuli. In an extension of the above two studies, Postman and Schneider (1951) obtained results which they interpreted as supporting the role of personal values in word recognition while also acknowledging effects of word frequency. They concluded that, in word perception, the use of low frequency words "slows down the recognition process and thereby affords an opportunity for such directive factors as personal values to influence the response" (p. 283). A strong objection to the word frequency interpretation was raised by Eriksen (1963), who checked the adequacy of the Thorndike-Lorge count as an index of frequency for neutral as well as taboo words. He concluded that the particular word count was misleading with regard to taboo words, great under-estimating the frequency count of such words.

Set has also been advanced to explain the perceptual selectivity effect. Lacy, Lewinger, and Adamson (1953) showed that a factor of expectation acted to reduce recognition thresholds more rapidly for taboo words than for the neutral words, and, also, that an habituation effect leveled the threshold differences which had occured initially between the classes of words. Postman, Bronson, and Gropper (1953) also found that subjects who expected taboo words showed reduced thresholds.

Freeman (1955) measured recognition thresholds of male and female subjects. Neutral and taboo words were presented and half of the subjects in each sex group were given advanced information that taboo words would be presented among the stimuli list. The uninformed groups had higher thresholds for taboo words. Sex was also significant, informed females showing less reduction of the taboo

word threshold than did informed males. Freeman argued that in place of perceptual defense interpretations, raised thresholds can be explained as a function of the dominance of alternative sets which do not predispose subjects toward the perception of taboo material.

A major criticism of the perceptual defense interpretation has been the concept of response bias, of which several forms have been described, i.e., report suppression, pure guessing, and fragment theory or sophisticated guessing. The basic view of response bias supporters is that the perceptual defense phenomenon can be explained not as perception but as subject response (Goldiamond & Hawkins, 1958; Minard, 1965). The subject was presumed to respond on the basis of "probabilistic verbal hierarchy determined by frequency factors, past reinforcement history, etc." (Erdelyi, 1974, p. 9).

The strongest case for a pure response bias interpretation was the study by Goldiamond and Hawkins (1958). Subjects, first trained with nonsense syllables were shown blank target slides at subliminal exposures. Despite the fact that no syllables had actually been presented, a frequency-threshold relationship was obtained, providing evidence for response effects rather than perception.

Erdelyi (1974) reviewed the evidence for and against response bias and concluded that, taken as a whole, response bias could not be supported as an adequate explanation for the perceptual defense effect.

An integrative view of the perceptaul defense concept was advanced by Erdelyi (1974). He proposed that an information-processing formulation of the concept was more comptaible with the totality of the research evidence, and that the concept could be placed within the framework of selective attention. He argued that "selectivity is a multi-process complex of phenomena under central executive control" (p. 1). The selectivity operation was theorized to be located at any of several possible sites within the information-processing continuum.

Subception

Subliminal processes have also been investigated as a source of threshold effects with affective stimuli. Lazarus and McCleary (1951) reported the first widely-recognized efforts. They obtained higher GSR's for shock than for non-shock words, leading them to conclude that subjects made automatic discriminations when they were unable to report conscious recognition. Subception (subliminal perception) was defined as a process by which some kind of discrimination is made when the subject is unable to make a correct conscious discrimination. Numerous studies have been reported as evidence for the effect (e.g., Dixon & Haider, 1961; Klein, Spence, Holt, & Gourevitch, 1958; Kolers, 1957; Somekh & Wilding, 1973). A lengthy review was written by Dixon (1971), in which he argued for a system of perception that mediates phenomenal experience which is separate from and parallel to that supporting overt behavior. Coltheart (1972) also supported the validity of the subception effect as a factor in word recognition processes. Somekh and Wilding (1973) argued that, assuming the legitimacy of the subception concept, incoming information is analyzed in much greater detail before selection processes determine what elements are processed further in the system. They interpreted Dixon as seeing the phenomena of selective attention and subception as end points on a single information-processing continuum.

Support for the subception concept is also found in the literature in neuro-psychology. Worden (1966) argued that "(the) facts of behavior indicate that even in narrowly focused attention, peripheral stimuli are admitted to the brain and evaluated in relation to their adaptive significance" (p. 94). Thompson and Bettinger (1970) discussed several types of neural control systems. The efferent pathways in specific sensory systems can act to modulate incoming sensory information. "(The) cortical association response fields

play a special role in controlling the attentive aspects of behavior" (p. 393). Samuels (1959), in a review of the reticular systems, argued that there is strong evidence for the critical role of the cortex in the selection and transmission of sensory inputs.

> If the perception of complex stimuli requires extensive supportive elaboration from non-specific sources in order to be retained as conscious memory, and if reticular input can be blocked during this period of consolidation by a discriminative center which is capable of monitoring its own input, then theoretical constructs such as "subception", "perceptual defense" and "repression" may have validity (p. 16).

Word Perception in the Peripheral Field

The neurophysiological characteristics of the vision system determine to a great extent what is seen on the printed page. The visual field that falls on the retina can be divided into three regions: the fovea, parafovea, and the periphery. The fovea, which is the region of highest acuity, subtends an area of 1° to 2° of visual angle around the fixation point; the parafovea subtends 2° to 10° ; and the periphery, about 10° out to the perimeter (Ditchburn, 1973). Acuity drops off rapidly from the fovea, by about 50% over a span of only 1° , however with enough detail still available in the parafovea (Cumming, 1978).

Large Eye Movements

Three types of large eye movements are involved in reading; tracking movements, where the head moves; vergence movements, which enables the eyes to converge; and saccadic movements, which are sudden changes from one fixation point to another (Gould & Schaffer, 1965).

The mean extent of the saccade has been estimated as about eight character spaces, or 2° of visual angle. However, within the individual, great variability was found in the range of saccadic extent, between 1 and 20 character spaces (Rayner, 1977).

Hochberg and Brooks (1970) characterized the saccadic movement as a ballistic movement in which the reader voluntarily directs the eye to a new fixation point, presumably as a result of the previous fixation. The time duration estimates of this movement has been given as 20 to 40 msec (Bouma, 1973).

Fixation durations have wider estimated ranges (e.g., 150 to 500 msec, Bouma, 1973; 200 to 250 msec, Rayner, 1977). Fixation durations are dependent on subjects' tasks. Gould and Schaffer (1965) reviewed several studies and found various average fixation durations reported, e.g., .28 sec where subjects scanned for 1/8-inch free-moving targets on a screen (Ford, White, & Lichtenstein, 1959); .157 sec was needed by subjects in Tinker's (1958) study, to fixate and correctly identify a letter following a saccadic movement; while Gerathewohl (1952) found fixation times up to 1.8 sec in more precise tasks.

Microsaccades

In addition to large eye mevements, smaller eye movements are of concern in word perception studies. Even as the eyes are supposedly still, during the fixation, unavoidable small movements occur. These "eye movements of fixation" are classified as tremor, drifts, and microsaccades (Cumming, 1978).

1. Tremor is a small, irregular lateral oscillation...
2. Microsaccades are small, fast, conjugate flicks, taking some 20 msec and moving the tyes a few minutes of arc.
3. Between microsaccades the eyes drift haphazardly...with tremor superimposed on the drifting motion (p. 224).

Studies of stabilized retinal images have demonstrated that the eye movements of fixation are vitally necessary for all normal visual perceptions. For example, if a retinal image is not continuously moved over the retinal mosaic, perception does not take place (Cumming, 1978). Microsac-

cades have usually been classified as involuntary, but there have been some evidence reported to indicate that these movements may be voluntarily controlled (Cumming, 1978). Gerrits and Vendrik (1974) found that microsaccades may play a role in the maintenance of non-foveal images. Zinchenko and Vergiles (1972) reported experiments where subjects under conditions of stabilized retinal images solved tasks. The authors speculated that under such task conditions "a mechanism compensating for image stabilization relative to the anatomical fovea comes into operation, and it can be likened to a functional fovea, moving over the field of perception" (p. 17). Attention, they feel, can be directed arbitrarily to different points of the stabilized image. Gaarder (1975) proposed a theory of systematic feedback mechanisms as components in a model of word recogiition, on the principle of homeostasis, which provide maintenance of vision. Microsaccades were seen as being one of these feedback mechanisms.

Relationship of the Fovea and the Periphery

The issue of the functional relationship between the foveal, parafoveal and peripheral fields of view in the reading process is unsettled (Cumming, 1978). Haber (1976) discussed the relationship and proposed three types of models, which differed in their hypothesized locus of control of eye movements in reading: the random control model, the internal control model, and the stimulus control model. In the random control model, eye movement is attributed primarily to processes in the oculomotor system itself, without feedback from higher centers. In the internal control model, eye movement is determined by the reader's processing of the text and the monitoring of it as he goes along. In the stimulus control model, all controls of internal control are present. In addition, graphic, syntactic, or semantic features of text in peripheral vision are utilized. Rayner and McConkie (1975) class-

ified models on the basis of theories about the nature of the processes during fixations. The cognitive lag hypothesis suggests that due to the rapidity of eye movements and shortness of fixation durations, there is a lag in semantic processing of the perceptual input, as in, e.g., the Kolers, 1976 model. The process monitoring hypothesis suggests that the eye movements and fixation durations are dependent on the cognitive processing of the input during the fixation. Bouma and DeVoogd (1974) theorized that careful placement of successive fixations is not required in reading, rejecting the necessity of peripheral analysis to guide eye movements.

Forgus and Melamed (1966) suggested that two tasks seem to be involved in an attentive tasks such as reading: (a) identification, which requires foveal vision, and (b) a decision about the next saccade, depending on information located in the periphery. They cited Neisser's (1967) model which hypothesized pre-attentive processing of peripheral information (the ground), which is followed by an attentive stage where focus is on the figure for specific information. Gould and Schaffer (1965), in a study of eye movements in scanning, found that many subjects detected target digits parafoveally, at an average distance of 2°13'. When the digit was one that was more easily perceivable, e.g., a 7, then peripheral vision was sufficient. If, however, the digit was more difficult to perceive, e.g., a 2, then another fixation, closer to the digit, was made. They concluded that the more easily perceived aspects of a stimuli field are detected with the same degree of acuity either in the fovea or in the parafovea, and when more difficult items are perceived in the periphery, the eyes make a saccadic movement to bring them to the fovea.

A model similar to Neisser's (1967) model was proposed by Hochberg (1970) and Hochberg and Brooks (1970). Their model was based on Hochberg's (1970)

theory of "focal consciousness" in which "the phenomenon of attention and the phenomenon of perceptual organization result from the normal exercise of self-practiced skills that are fundamental to the perceptual process" (Hochberg, 1970, p. 99). One assumption was that selective attention involves the testing and remembering of one set on anticipations rather than another. Perceptual organization arises predominantly out of ways in which those sets of anticipations are structured.

Based on the above theory, an anticipatory mechanism was incorporated into their version of the active reading process (Hochberg & Brooks, 1970). Their two-stage processing model has, first, a peripheral search guidance stage, during which cues are detected in the periphery and screened for importance. Saccades then bring relevant cues to the fovea for the second stage, cognitive search guidance, for higher-order processing. Thus, certain peripheral operations occur before subsequent higher-order processing takes place. Critical to this model is the assumption that dependency or efficiency in processing this peripheral information increases with age and experience. The skilled reader uses redundancies perceived in the periphery to correctly anticipate the message, thus actually needing fewer fixations.

Support for Hochberg's model was presented by Fisher and Lefton (1976). They manipulated word boundary (spacing) and word shape (case) in a natural reading situation. Their conclusions were that the data demonstrated the "efficiency with shich the periphery processes physical featural information increases with experience and as the reader becomes more efficient there is an increasingly greater dependency upon peripheral information to maintain that efficiency" (p. 92). Spragins, Lefton, and Fisher (1976) also reported similar conclusions supporting the developmental thesis in the use of peripheral cues in reading. Holmes, Cohen, Haith and Morrison (1977)

investigated the developmental aspects of identifying geometric form stimuli in the periphery. They found significant main effects for age, distance and form conditions. Accuracy improved with age and decreasing distance from fixation.

Malt and Seamon (1978) reviewed models of eye movement control in reading. They concluded that there was evidence in the literature to support both the peripheral guidance hypothesis and the cognitive guidance hypothesis. Rabbitt (1978) gave a succinct summary of the view that there is a close, complementary relationship between the foveal and non-foveal fields of view:

> (The) evidence leaves no doubt that when subjects identify words on crowded displays, whether their task is defined as vidual search or reading, they use peripheral cues to determine the extent of each successive saccade and so the size of the sample of text that they process during a single fixation...It seems likely that people can simultaneously extract the information which they need to identify works they currently fixate a different kinds of information that guides their choice of the point of their next fixation (p. 123-124).

With regard to the span of peripheral vision there have been varying estimates, depending upon experimental tasks. In general, acuity decreases with increasing distance (eccentricity) from fixation. Kerr (1971) reported new data that led to revised estimates of acuity in the periphery. Using improvements in the experimental design, Kerr established new determinations of acuity at 10°, 20°, and 30° from the fovea, which were two to four times higher than those given by earlier experimenters. The target display was a 3°-square grating field.

Bouma (1971) found no left-right visual field differences for recognition of single letters in the parafovea. Recognition of isolated words, however, has been shown to be better in the right visual field (Bouma, 1973; Mishkin & Forgays, 1952). Bouma (1973) found, additionally, lower recognition

scores in the left field with increasing word length. At the same eccentricities, outward letters of words were better seen than inward letters.

Rayner (1975) replicated an earlier study by McConkie and Rayner (1973) on the perceptual span in reading. Both studies utilized the computer and rapid display changes made possible by it. The earlier study had shown that the reader acquires information about word shape and specific letters no more than about ten character spaces into the periphery. Rayner (1975), using college-age subjects instead of high school-age students, found that word length information is acquired further from the fixation point, at least 12 to 15 character spaces. At 7 to 12 spaces away, the subject was able to perceive gross characteristics such as word shape and initial and fianl letters. Rayner also found that the reader was able to make a semantic interpretation of the word located one to six character spaces from the point of fixation.

Dunn-Rankin et al. (1979) theorized that the relative interaction of syntactic and affective characteristics of words are important cues to word recognition in the periphery. Analysis of the frequency data in their study led to the conclusion that there were no significant syntactic effects, but that the emotional words were perceived more frequently in the peripheral field than could be expected by chance alone.

Summary of the Review

This section will summarize the review of the literature and implications for this paper. The relevant literature was reviewed under the following topics: (a) general information-processing models, (b) models of word recognition, (c) variables in word recognition, and (d) word perception in the peripheral field. In terms of this proposal, the topics (a) and (b) provide a general approach and background for the proposed study. Topics (c) and (d) provide more specific context for this experiment.

The information-processing approach was seen as a useful method for theorizing about the cognitive processes, i.e., in the reading act. The locus of selective attention, whether "early" or "late" in the continuum was addressed by different theorists (Broadbent, 1958; Deutsch & Deutsch, 1963; Treisman, 1964). Norman (1969) evolved a "single memory" thesis from an earlier "dual memory" system (Waugh & Norman, 1965); he postulated that selective attention in the former model was based upon pertinence evaluations of the stimuli. Chase (1978) compared the early models (Broadbent, 1958) with a "second generation" model (Haber & Hershenson, 1973) and noted that there was a trend to several modality-specific peripheral memories, the replacement of the limited-capacity communication channel by short-term memory as the central structure, and the closer juxtaposition of long-term to short-term memory. The implications are that there is almost immediate contact with long-term memory in the processing of stimuli; contact with meaningful coding of the stimulus item is thus postulated early in the flow.

The review then focused on a smaller portion of the total information-processing continuum, i.e., the early stages, especially the iconic memory stage (Sperling, 1960, 1967). Theorized operations involved in very brief stimuli presentations are relevant since this study used tachisto-

scopic exposures below typical fixation durations. The nature of iconic memory, earlier regarded as being precategorical (low-order, undifferentiated) was challenged by Coltheart (1980) who proposed that iconic memory is a cortical representation of a higher order of processing. Masking was seen as a method for controlling after-image effects (Breitmeyer & Ganz, 1976; Kahneman, 1968; Turvey, 1973) in analyzing the icon in information-processing.

Models of word recognition were reviewed, focusing especially on the issue of serial- or parallel-processing of the stimuli. The parallel-processing position is judged as compatible with the hypothesis that stimuli may be directly processed for meaningful content (Theios & Muise, 1977). This was opposed to , for example, Gough (1972), who argues for a serial, letter-by-letter processing in word identification. Anderson's (1977) neural model seems to provide an explanation for differential response rates for stimuli with different past history; items with more "strength" are processed faster, accounting for lower recognition thresholds.

Variables investigated in word recognition studies were reviewed: graphic, phonological, orthographic, syntactic and semantic. Frequency, familiarity, and subject expectations were also relevant (Gibson & Levin, 1975). Graphic features such as confusability (Bouma, 1971; Dunn-Rankin, 1968), effects due to type case (Tinker, 1955), and word length would need to be controlled.

Word frequency effects have been amply demonstrated (Avant & Lyman, 1975; Howe & Solomon, 1951; Postman & Rosenzweig, 1957). Stimuli words may be equated for frequency by using the American Heritage Word Frequency Book (Carrol, Davies, & Richman, 1971) and Computational Analysis of Present-Day American English (Kučera & Francis, 1970). Since the latter count is based on college-level material, it was the chief source of frequency data.

Semantic characteristics were discussed under various headings. The salience of the word as a meaningful unit in recognition was studied (Gibson et. al., 1964; Henderson, 1978; Osgood & Hoosain, 1974). Baron (1978) and Novick (1974) argued that words can be identified directly from letter-patterns, by-passing the phonological analysis stage. Similarly, automatic activation of word meanings was advanced by Hasher and Zacks (1979).

The effects of emotionally-laden words as stimuli were reported in numerous studies (Manning & Julian, 1975; McGinnines, 1949; Newton, 1955; Weiner, 1955). Sex of subject was seen to have an effect on the response to taboo words (Bitterman & Kniffin, 1953; Freeman, 1955). Subject expectations also affected response (Lacy, et., al., 1953; Postman, et. al., 1953). Response bias as a explanation for the perceptual defense effect was supported (Goldiamond & Hawkins, 1958; Minard, 1965) but also rejected (Erdelyi, 1974).

Subception as an explanation for threshold effects with affective stimuli was supported (Dixon, 1971; Klein, et. al., 1958; Somekh & Wilding, 1973). Neuropsychological bases to support the subception theory was provided by Samuels (1959), Thompson & Bettinger (1970), and Worden (1966).

A functional relationship between the fovea and the periphery in reading was theorized by Hochberg and Brooks (1970), who postulated a two-stage model of reading where peripheral information lead to higher-order foveal operations. Fisher and Lefton (1976) found empirical support for the Hochberg model. Rayner (1975) used computer displays to determine perceptual spans in the fovea and peripheral fields. Dunn-Rankin et. al. (1979) found that emotionally-loaded words were recognized more often than other words in the peripheral field under brief exposures.

CHAPTER III. STATEMENT OF THE PROBLEM

The problem that was investigated was the effect on the recognition rates of "emotionally-loaded" words and "neutral" words in the parafoveeal field presented in very brief exposures. This experiment was an extension of the study by Dunn-Rankin et al (1979), which will be hereafter referred to as the original study. The assumption underlying the original study was that "within a given frame of reference different cues are relatively important to recognition" (p. 2). The original study tested the hypothesis that presentation of sets of words, i.e., a noun, a verb, and an adjective, of equal length and frequency, plus an "emotional" word, would result in differences in word recognition under brief exposure conditions. Since the four words were arrayed in two rows equidistant from the foveal area, the task also involved acuity in the parafoveal field. The stimuli were presented in group sessions, by projection from a slide projector, at 1/60th of a second.

The data indicated that recognition of words in the parafoveal field is not made randomly; emotional words had frequencies well above a random mean, while the other words were below the mean. The syntactic aspects (parts of speech) did not have a significant influence.

The present investigation modified certain elements of the original study, thusly:

1. Adults only were used, as subjects, in order to eliminate possible confounding effects of developmental factors.

2. Subjects were tested individually, using a tachistoscope.

3. Stimuli consisted of word-pairs: an emotional word and a neutral word or neutral word with another neutral word, rather than four words.

4. Exposure durations were at 30 msec and 40 msec, rather than at 1/60th of a second.

5. Masking was used in the procedure for better control of the duration of the target display. Sperling (1963) noted the possibility of a negative after-image of the stimulus without the target display being effectively seen. Dick (1974) discussed the use of dark fields in forward as well as backward-masking.

The rationale for the present experiment was as follows: Word recognition involves a response to a stimulus with a complex of features, including frequency, graphic and affective. The affective component of a word can be represented by its rating on a scale of "word potency". Words with high potency are typically taboo words, toilet words, or violence words, e.g., fuck, shit, kill and rape. Examples of words lower on the potency continuum are fact, shut, hill and rope. Brief exposures, i.e., too short for eye movements, would provide a condition for testing the word potency effect. Given a pair of words, both similar in frequency and graphic characteristics, i.e., word-length, letters, and word-shape, presented at 30 msec, word potency should have a significant effect on recognition. The word potency effect should hold even in the parafoveal field. Such theories of reading as Hochberg (1970) assert a functional relationship between preliminary scanning of the peripheral field and subsequent foveal processing. Rayner (1975) has previously shown evidence of semantic differentiation in the parafoveal field, but under conditions simulating reading. The present experiment should provide more empirical data on word recognition effects in the parafoveal field.

The experimental design in this study was a comparison of word recognition scores of males and females randomly assigned to two treatment conditions, control words and experimental words.

CHAPTER IV. MATERIALS AND METHOD

Subjects

Subjects were 72 (36 male, 36 female) in the main sample, Sample I, and 20 (6 male, 14 female) in the smaller sample, Sample II. Aside from different exposure conditions in the samples, all conditions of the experment were identical for both samples. Subjects were students recruited from various courses at the University of Hawaii at Manoa. Subjects read and signed a waiver form. Separate appointments were made for each subject for an experimental session. Subjects were paid $4.00 for the session, except for 10 students, who received extra credit in their psychology course, instead of the fee, for their participation.

Stimuli

The experiment was designed as a test of the hypothesis that, given words matched for graphic similarity and frequency, emotional words will be recognized more often than neutral words. The emotional words were selected on the basis of a review of the literature and a preliminary validation study. Based upon the review, the following words were selected as potential stimuli for further validation: crap, drug, fuck, kill, love, piss, rape and shit. A validation study, using 31 female and 25 male college students, was conducted to evaluate the affective nature of the words. The subjects made paired-comparisons of the words on the dimension of "potency". The data was analyzed for scale values, using the computer program COMPPC (Gulliksen, 1958). The scale values were then subjected to multiple comparisons for significant differences among the pairs in each set (Dunn-Rankin, n.d., p. 47). The analysis showed agreement between female and male subjects on their ratings of six of the emotional words as significantly different from the neutral words: crap, fuck, kill, love, rape and shit.

Each of the six emotional words was associated with two neutral words, hereafter referred to as "foils", selected on the basis of graphic similarity and frequency. Graphic similarity included such considerations as same, or similar, beginning and ending letters, and same, or similar overall shape. Thus, for example, crap and crop are very high on similarity.

Frequency, as the second criterion for selection of the respective foils, was based on the rationale that matching the emotional word with a word of equal frequency would control a source of bias in word recognition. However, based on frequency values available in the Kučera-Francis word count (Kučera & Francis, 1970), four of the emotional words, crap, fuck, rape, shit, had frequencies much lower than their neutral foils. Kill was rated slightly lower and love was higher than their foils. Thus, it was not possible to provide for equality of frequency for the emotional words and respective foils.

The treatment variable words were arranged in two groups, Control words and Experimental words. The Experimental set consisted of the six emotional words and their foil words presented in word pairs. In the Control set, only neutral words were used in word pairs. Each group thus consisted of six sets of words, totalling 36 pairs in each group.

Each set consisted of three words: a key word, foil-word 1, and foil-word 2. Each word was paired with the other two in both left- and right-hand configurations, for a total of six pairs of words for the set. In the Control group, the key word was the foil-word 1 for the keyword in the Emotional counterpart set. This neutral key word was provided with its two foil-words, i.e., foil-word 2 of the counterpart Emotional set, and another foil, selected for frequency and graphic similarity. The complete array of the stimuli words are presented in Table 1.

Table 1. Stimuli Sets in Treatment Variable

	Control Words			Experimental Words	
Set 1.	crop-coop	coop-crop*	Set 1.	crap-crop	crop-crap*
	crop-chop	chop-crop		crap-coop	coop-crap
	coop-chop	chop-coop		crop-coop	coop-crop
Set 2.	fact-luck	luck-fact*	Set 2.	fuck-fact	fact-fuck*
	fact-duck	duck-fact		fuck-luck	luck-fuck
	luck-duck	duck-luck		fact-luck	luck-fact
Set 3.	bill-hill	hill-bill*	Set 3.	kill-bill	bill-kill*
	bill-fill	fill-bill		kill-hill	hill-kill
	fill-hill	hill-fill		bill-hill	hill-bill
Set 4.	live-lose	lose-live*	Set 4.	love-live	live-love*
	live-lone	lone-live		love-lose	lose-love
	lose-lone	lone-lose		live-lose	lose-live
Set 5.	rope-ripe	ripe-rope*	Set 5.	rape-rope	rope-rape*
	rope-rage	rage-rope		rape-ripe	ripe-rape
	ripe-rage	rage-ripe		rope-ripe	ripe-rope
Set 6.	shot-shut	shut-shot*	Set 6.	shit-shot	shot-shit*
	shot-shop	shop-shot		shit-shut	shut-shit
	shut-shop	shop-shut		shot-shut	shut-shot

* Starred words are key words in each set. Hyphens not used in actual stimuli cards.

The criterion measure was the number of correct responses (recognition) of the key words in each of the treatment conditions.

Materials

The words were presented inpairs on white 5 x 7 inch cards in a tachistoscope with a viewing distance of 49.5 inches. Based on the assumption that the typical reading distance is 14-17 inches, which is approximately 1/3 the actual distance of 49.5 inches in the tachistoscope, the required size of the stimuli words was determined to be three times the height of pica -type, or 30 points. Thus, Letraset brand, Helvetica Light 30-point transfer letters were used to create the stimuli displays. The words were placed horizontally across the middle, equidistant from the center, with appropriate spacing between words. Based on the literature

review (Bouma, 1971; Dunn-Rankin et al, 1979; Gould and Schaffer, 1965; Lefton and Fisher, 1976; Rayner, 1977), the span of a fixation for words in pica-type was estimated to be 12 character spaces encompassing about 4° of visual arc. Consequently, the analogous Letraset words were prepared with the following measurements:

(1) Distance from fixation point to words: 3 character spaces.

(2) Total separation between words : 6 spaces

(3)Total span of word pair : 14 spaces, or 84 mm.

The actual visual arc during the experimental sessions, determined by trigonometric calcuation, was $3^{\circ}26'$, or about $3\frac{1}{2}^{\circ}$.

A pre-trial blank field with a focusing mark, consisting of a +, 18 mm in height and width, in the center of the field, was visible before and after the exposure of the target and masking fields.

A backward-masking noise-pattern field was used for controlling the duration of the physically available stimuli. A noise field made up of fragments of letter material of the same Letraset material were randomly arranged in a dense manner on two cards. Due to the uniformity of the noise-pattern fields thus created, these two cards could be used bottom-side up as well as right-side up, i.e., rotated 180°. Thus, random use of the two cards yielded four different masking fields, helping to prevent possible biasing effects of the coincidental combination of a stimuli card with a masking field (Eriksen, 1980; Uttal, Note 1).

Equipment and Facilities

The facilities at the Bekesy Laboratory of the Pacific Neurobiological Research Center on the Manoa Campus of the University of Hawaii was used. The equipment was a three-field Scientific Prototype tachistoscope, Model GB. Luminance intensity ratio of the three fields was 6:6:3 for Target, Mask and Blank fields, respectively. A portable tone generator was used to produce an audible cue to signal the onset of the target display.

Procedure

Subjects were tested individually. Each session lasted about 30 minutes. The Investigator acted as the Experimenter. The subject was given standard verbal directions, as follows:

> "This is a test of how well you can recognize words. Pairs of words will be flashed on the tachistoscope screen. Your task is to write down the words you see, on the answer sheet provided, after each trial. There will be a different pair flashed at each trial, for a total of 36 trials.
>
> You will be given a few practice trials to familiarize you with the procedure, as follows:
> (1) I will say "Next", pause a few seconds, and
> (2) Turn off the room lights. This will be the signal for you to place your head in the viewing position, and look at the visible blank screen, focusing on the + mark.
> (3) One second after lights are switched off, an audible tone will be heard, for about a second.
> (4) Immediately at the end of the tone, the word pair will be flashed on the screen, followed quickly by a masking field.
> (5) The initial blank field will then come on, completing the trial.
> (6) The room lights will be turned on, and you will write down your response.
>
> It is very important that you try to see <u>both</u> words of each pair, rather than either word only. Do not be surprised at the words; try to be as accurate as possible. Do not let your feelings get in the way of your performance."

The tachistoscope control unit was programmed for an automatic cycle, which began when the Experimenter pushed the activator button coincidental with the termination of the audible tone. The cycle was as follows:

1. PRE-TRIAL : Blank field is ON.
2. SWITCH ON
3. BLANK CHANNEL : Blank field on for 900 msec.
4. CHANNEL 1 : Target field on for 30 msec.
5. CHANNEL 2 : Masking field on for 750 msec.
6. POST TRIAL : Blank field is ON.

The Experimenter manually changed the stimuli cards in Channel 1, the target field, for each trial. Also, for randomization of the masking field, the masking card was rotated in Channel 2 mid-way through the session. Card changes took only a few seconds.

Subjects were given a few practice trials, using prepared practice word sets. They were then give 10-15 trials of a base-line set of word-pairs, to determine each subject's appropriate exposure duration, i.e., 50 msec, 40 msec, or 30 msec. The base-line set were 36 pairs of 4-letter words selected for similarity to the actual test words, in terms of graphic characteristics and frequency. Examples of the base-line set are as follows: loud-load, foot-feet, race-role, limp-lamp, cord-card, slim-stem. By a "cut-and-try" procedure, the proper base-line exposure duration was quickly determined for the subject, requiring typically, 12-15 trials. The sought-for base-line was a 50-percent rate of correct recognition; actual range of response rates was 45-55%. Once the base-line exposure duration was determined, the actual test trials commenced.

Depending upon the base-line determination, the subject was then immediately placed in the proper exposure condition group, i.e., 50 sec, 40 msec, or 30 msec.. By reference to a running-tally of the treatment groups, the subject was assigned on an alternating basis to the Experimental or Control group of his appropriate exposure group.

Subjects responded orally immediately after each practice and base-line trial. Once test trials commenced, only written responses were made, on prepared response forms. There were two blocks of 18 trials with a minute of rest between blocks. For each session-day, which involved 1 - 4 subjects at separate times, the appropirate stimuli was presented in a different randomized order, with the constraint that word-pairs from any one set were not presented in a back-to-back sequence, e.g., "crop-coop" followed by "coop-chop".

Immediately after the 36 test trials were completed, a "post-test" series of the base-line set, using "fresh" cards, was made, to confirm the validity of the "pre-test" exposure duration, his base-line, for the subject. Very few deviations from the pre-test base-line determinations

were found, these deviations generally on the order of 3-5 percentage points higher.

A short "de-briefing" session, explaining the theory underlying the experiment, was then given for the subjects in the Experimental groups. Subjects were cautioned not to discuss the nature of the stimuli words with friends, who could be potential subjects. Spot-checking on this point, by talking to subjects, indicated that there no "loose-talk" violations of this nature.

CHAPTER V. RESULTS

The data was analyzed by two-way analysis of variance and multiple regression. The two samples were subjected to separate analyses.

Two-Way Analysis of Variance

The SAS computer program, General Linear Models procedure, was utilized for the two-way ANOVA. The dependent variable was the criterion score, i.e., total number of key words correctly recognized by each subject. Independent variables were Sex (Male and Female) and Words (Control and Experimental). Descriptive statistics for the two samples are presented in Tables II.a. and II.b.

Table II.A. Descriptive Statistics for Sample I (30 msec) N = 72

GROUP	N	SUM	RANGE	MEAN	STD. DEV.	VAR
Male-Control	18	219	6 - 19	12.17	3.68	13.56
Male-Exper	18	280	7 - 22	15.56	4.57	20.85
Female-Control	18	250	9 - 19	13.89	2.63	6.93
Female-Exper	18	296	10 - 22	16.44	3.33	11.08

Table II.B. Descriptive Statistics for Sample II (40 msec) N = 20

GROUP	N	SUM	RANGE	MEAN	STD. DEV.	VAR
Male-Control	3	38	12 - 14	12.67	1.15	1.33
Male-Exper	3	26	7 - 11	8.67	2.08	4.33
Female-Control	7	67	7 - 12	9.57	1.72	2.95
Female-Exper	7	87	9 - 17	12.43	2.44	5.95

Sample I (30 msec, N= 72)

The ANOVA Table, derived from the computer program output, is presented in Table III.

Table III. Two Way ANOVA for Sample I (30 msec). N = 72

SOURCE	DF	SS	MS	F	PR > F	R-SQ	STD. DEV.
Model	3	192.8194	64.2731	4.90	0.004	0.1778	3.6201
Error	68	891.1667	13.1054				
Corrected Total	71	1083.9861					

SOURCE	DF	TYPE I SS	F	PR > F	DF	TYPE IV SS	F	PR > F
Sex	1	30.6806	2.34	0.1306	1	30.6806	2.34	0.1306
Words	1	159.0139	12.13	0.0009	1	159.0139	12.13	0.0009
Sex X Words	1	3,1250	0.24	0.6269	1	3.1250	0.24	0.6269

There was a significant over-all effect for the model. Type I and Type II SS analysis showed that there was a significant effect of Words, but Sex and Sex by Words interaction were not significant.

The finding of no difference between Males and Females in Ssample I was given additional support by an analysis of concordance, i.e., Kendall's Tau. Criterion scores for all stimuli words were rank-ordered and subjected to concordance analysis. The comparison of Male and Female Control groups yielded T=.76, while the Male and Female Experimental groups yielded a T =.84.

Sample II (40 msec, N= 20)

The ANOVA Table for Sample II is presented in Table IV.

Table IV. Two Way ANOVA for Sample II (40 msec). N = 20

SOURCE	DF	SS	MS	F	PR > F	R-SQ	STD. DEV.
Model	3	53.0381	17.6794	4.34	0.0199	0.4502	2.0119
Error	16	64.7619	4.0476				
Corrected Total	19	117.8000					

SOURCE	DF	TYPE I SS	F	PR > F	DF	TYPE IV SS	F	PR > F
Sex	1	0.4667	0.12	0.7386	1	0.4667	0.12	0.7386
Words	1	3.2000	0.79	0.3871	1	1.3714	0.34	0.5686
Sex X Words	1	49.3714	12.90	0.0030	1	49.3714	12.20	0.0030

the Sex by Words interaction. There were no significant effects for Words or Sex.

The Sex by Words interaction in Sample II can be attributed to the opposite responses of the Male and Female groups to the Control and Experimental words. Means data in Table II.b. show that the Male Controls had a higher mean (12.67) than the Male Experimental group (8.67). The Females showed an opposite tendency: mean for Controls (9.57) was lower than the Experimental mean (12.43).

Thus, Females in both samples were more consistent in that both of their Control groups had lower means than their respective Experimental groups. Males, however, in Sample I had a lower Control mean than the Experimental group, thus showing inconsistency across the samples. However, within size for Sample II males of 6, this effect may be considered unreliable. Sample I finding of a consistent response across word sets for both Males and Females carry more weight, due to the larger sample size, ignoring the different exposure conditions.

Regression Analysis

Regression analysis provided further insight into the data from each sample, i.e., the relative contributions of different variables involved in in the recognition of the words. In this analysis, the dependent variable, Y, represented the total number of correct responses for every word in each of the stimuli sets, grouped by treatment groups: Male Control, Male Experimental, Female Control, Female Experimental. Independent variables were selected, on the basis of their probable contribution to the criterion score:

1. Word Potency : In scale values developed from the paired comparison studies
2. Frequency : In rank values of the Kucera-Francis word count.
3. Ascenders : In frequency of letters such as b, l, k, h, f, and t within the word
4. Density : In values by adding density values for each letter in the word
5. Sex : 1 for Male, 0 for Female.

Ascenders were thought to be an important graphic cue in letter recognition, since the reader generally focuses on a point just above the letters as he reads (Dunn-Rankin, 1978). Thus, letters with ascenders should be easier to recognize.

Density was proposed as a source of variation in the recognition of words under the experimental conditions, i.e., parafoveal location and very brief exposures. Letters represent particular graphic patterns that must be discriminated and differentiated in the early stages of perception. The complexity of those graphic patterns differ from letter to letter, ranging from simple to complex. Thus, a word may represent a totality of patterns which may be light or dense, depending on the combination of letters. A system for scaling density was devised, by projecting a grid on a blown-up image of the letters used in the experiment. The number of grid intersections within the area encompassed by the letter was counted, thus arriving at a value representing its density. For example, fill has

a density of 80, while shop has a density of 151.

The complete array of values for all the variables in the regression analysis for each sample are presented in Appendix 1. and 2.

The results of the regression analysis for Samples I and II are presented in Tables V.a. and V.b., respectively.

Table V.a. Regression Analysis for Sample I Words

SOURCE	DF	SS	MS	F	PR > F	R-SQ	STD. DEV.
Model	6	6206.7629	1034.4605	8.60	0.0001	0.4425	10.9684
Error	65	7819.8899	120.3060				
Corrected Total	71	14026.6528					

SOURCE	DF	TYPE I SS	F	PR > F	DF	TYPE IV SS	F	PR > F
Potency	1	1473.5140	12.25	0.0008	1	787.9014	6.55	0.0128
Frequency	1	0.3405	0.00	0.9577	1	447.8017	3.72	0.0581
Ascenders	1	3425.7357	28.48	0.0001	1	1399.3107	11.63	0.0011
Density	1	938.4250	7.80	0.0069	1	1038.7237	8.63	0.0046
Sex	1	357.8799	2.97	0.0893	1	21.1233	0.18	0.6766

Table V.b. Regression Analysis for Sample II Words

SOURCE	DF	SS	MS	F	PR > F	R-SQ	STD. DEV.
Model	6	851.5144	141.9191	7.87	0.0001	0.4207	4.2470
Error	65	1172.4300	18.0374				
Corrected Total	71	2023.9444					

SOURCE	DF	TYPE I SS	F	PR > F	DF	TYPE IV SS	F	PR > F
Potency	1	57.6993	3.20	0.0783	1	46.2616	2.56	0.1141
Frequency	1	1.6954	0.09	0.7601	1	3.2201	0.18	0.6740
Ascenders	1	106.6942	5.92	0.0178	1	57.0883	3.16	0.0799
Density	1	0.0014	0.00	0.9931	1	17.8610	0.99	0.3234
Sex	1	681.0980	37.76	0.0001	1	75.0542	4.16	0.0454

Regression analysis for Sample I Words showed an over-all significcant effect; R-Square was .4425. Of the five variables, Word Potency, Ascenders, and Density were significant, while Frequency and Sex were not.

Sample II Words regression analysis also indicated an over-all significant effect for the model. R-Square was .4207. However, the only variable with a significant Type IV SS F value was Sex. This effect of Sex on the responses to words in Sample II paralleled the finding in the ANOVA for Sample II, which indicated a significant Sex by Words interaction.

Additional Analyses

Additional analyses conducted on the data were the following: (1) hit rates of the treatment groups, (2)left and right field frequencies, and (3) reversal frequencies.

Hit Rates

T ables VI.a. and VI.b. present the data on the rates of correct responses to total words correct and to the grand total (total words possible), by samples. The data for Sample I clearly mirror the earlier ANOVA and regression analysis data for the Sample; the groups show consistency across sex in their responses, viz., the Controls for both sexes have similar A/B and A/C hit rates (.34 and .35; .17 and .19). The Experimentals also are similar in their rates (.38 and .37; .22 and .23). Comparison across Sample I and II show that the Males are consistent in their A/C rates (.17 and .18 for Controls; .22 and .23 for Experimentals). Females, however, show a definite drop in A/C hit rates (.19 and .13 for Controls; .23 and .17 for Experimentals). The latter decrease of .06 for the Females in Sample II is mirrored by significant Sex and Sex by Words interaction effects noted earlier in the regression analysis and ANOVA for Sample II. Taken together, the evidence seems to point to differences in reponses of the Female subjects due to different exposures. They

scored better at 30 msec than at 40 msec, unlike the Males, who showed more consistency across both exposure conditions.

Table VI.a. Hit Rates for Sample I, by Treatment Groups

GROUP	N	A. SUM OF CORRECT RESPONSES	B. SUM OF TOTAL CORRECT	HIT RATIO A/B	C. GRAND TOTAL WORDS	HIT RATIO A/C	HIT RATIO B/C
Males-Control	18	219	637	.34	1296	.17	.49
Males-Exper	18	280	730	.38	1296	.22	.56
Females-Control	18	250	716	.35	1296	.19	.55
Females-Exper	18	296	792	.37	1296	.23	.61

Table VI.b. Hit Rates for Sample II, by Treatment Groups

GROUP	N	A. SUM OF CORRECT RESPONSES	B. SUM OF TOTAL CORRECT	HIT RATIO A/B	C. GRAND TOTAL WORDS	HIT RATIO A/C	HIT RATIO B/C
Males-Control	3	38	107	.36	216	.18	.50
Males-Exper	3	49	144	.34	216	.23	.67
Females-Control	7	67	204	.33	504	.13	.40
Females-Exper	7	87	267	.33	504	.17	.53

Reversals (Sample I Data Only)

Word pairs correctly recognized, but reported in reverse order, were not counted as correct responses. However, the fact of having both words of the pair correct seems to indicate that recognition of the words did occur, but that spatial location had not been clearly established. While the total number of reversals was small (90 out of total possible, or 7%), it

is interesting to note that 26 out of 72 subjects, or 36 % , in Sample I had at least one case of reversal. There were more Females (17) than Males (9). Two subjects, both females, had five cases each. Word sets with most frequencies of reversals were rape-rope-ripe, shot-shut, and kill-hill-bill.

Left and Right Field Frequencies

An issue in earlier studies of single word recognition has been that of left or right field dominance. In Sample I, the following results were obtained: (a) Males across word groups showed a tendency to recognize more words in the right field (22 to 14); however, total words recognized for all responses were almost equal (L= 369; R= 364). (b) Females, on the other hand, showed the opposite tendency: they had more subjects who saw more words correctly in the left field (20 to 15, 1 tie), and they also saw more total words in the left field (L= 421; R= 370). Thus, the results indicate a possible sex difference. The Female data are also contrary to the findings of Bouma (1973) and Mishkin and Forgays (1952), who found better right field word recognition rates.

CHAPTER VI. DISCUSSION

The experimental results, while limited to a population of college students, give support to the theory that the affective dimension of words have a significant effect on the complex process of word recognition. As noted in the review of the literature, word recognition may be characterized as dependent on a complex of features: graphic, phonological, orthographic, semantic and syntactic. In addition, subject expectations come into play. In this experiment, significant effects of the semantic feature, i.e., word potency, and graphic features, i.e., the presence of ascenders and density, were clearly evident. The data on word potency support many reported studies of the effect of the meaningful or affective dimension in word recognition (e.g., Dunn-Rankin et al, 1979; Manning & Julian, 1975; McGinnies, 1949; Weiner, 1955). As for the effects of ascenders found in the regression analysis, Dunn-Rankin 's (1978) observation that the reader focuses on a point just above the letters as he reads is clearly corroborated by the significant effect of ascenders. In the experiment, the bill-kill-hill-fill words had high recognition scores, providing strong evidence for this effect.

The effect of density, as scaled in the experiment, was also a significant graphic variable. Under the atypical visual conditions of the experiment, i.e., very short exposures, and the parafoveal location, the density of the words evidently multiplied lateral masking effects, especially of the interior letters.

Taken together, the data on ascenders and density have implications for the design of graphic effects in television and computer terminal displays, where legibility and quick absorption of messages are prime considerations. Lateral masking effects due to density, and choice of

alphanumerics and symbols, may be of critical importance in determining the effectiveness of such displays.

Frequency was not a significant variable in this experiment, contrary to earlier studies (Howes & Solomon, 1951; Postman & Scneider, 1951). In those studies the stimuli represented wider scope of lexical possibilities. In the present experiment, constraints on the selection of the stimuli words may have contributed to the negation of the frequency effect. While selection of neutral foils was based on equal frequency with key words, the use of four-letter words limited possible choices. In the end, four emotional words, crap, fuck, rape, and shit, were each provided with foils of higher frequencies. Kill had aslightly lower frequency than its foils, while love had a higher frequency than its foils. Thus, the condition of equal, or similar frequencies was not uniformly obtained for all sets.

The effect of spatial location, i.e., separation of the paired words so that they fell in the parafoveal field, was one of the main concerns in this study. Rayner (1975) found that semantic interpretation of the word located one to six character spaces from the point of fixation was possible; his experimental conditions simulated a fairly "normal" reading situation. In the present experiment, the subjects saw static, isolated word - pairs in separate presentations. The word-pairs spanned 14 character spaces, or about $3\frac{1}{2}^{0}$ of arc. The potency data showed that semantic interpretation, i.e., recognition, of words in the parafovea under very brief exposures are possible. There are definite implications for television, computer displays, or large outdoor or building displays. However, more empirical data are needed on the interaction of spatial location, luminance factors, and graphic variables on visibility and comprehension by the viewer.

While the paradigm utilized in the experiment was not precise enough to yield better evidence, the results may be seen as generally supportive

of the information-processing theories of cognition. The exposure durations, 30 msec and 40 msec, are apparently very close to the minimum necessary for the majority of subjects. Most of the subjects tested to the base-line of 30 msec, while the next largest group were the 20 subjects who comprised the 40 msec sample. A few subjects were able to perceive and recognize words at durations as short as 20 msec. A few, on the other hand, required 50 msec or more to achieve base-line levels. These could have been cases of poorer-than-normal vision.

That the target words were recognized under such brief exposures seem to support theories of parallet-processing in the initial stages of information-processing (Theios & Muise, 1977) and very early contact with lonsg-term memory (Anderson, 1977; Deutsch & Deutsch, 1963; Norman, 1969). Serial-processing theories (Gough, 1972) which postulate a letter-by-letter development of the word recognition process would seem to be unable to account for the subject responses at 30 msec and 40 msec.

While the experimental paradigm did not provide more specific data on which precise durations of the information-processing stages may be estimated, a speculative view is offered here on possible times involved. The experiment suggests a sensory input stage of at least 30 msec. An estimate of the stages involving perceptual coding and contact with long-term memory lexicons for word recognition may be made at an additional 50 -150 msec. The response stage may entail another 300 - 500 msec. Thus, a total time lapse from sensory input to beginning a response may take around 500 - 700 msec. These speculative times are advanced on the basis of subject oral responses during the practice and base-line procedures of the experimental sessions. Many subjects began their oral response, e.g., "loud-load", very early, even during the 750 msec segment of the cycle. Thus, they were responding well within 700 msec of total lapsed time.

It is further speculated that, once recognition is achieved in the information-processing continuum, the mechanism of selective attention determines further processing. Somehk and Wilding (1973) advanced the theory that subception processes make it possible for analytic processing of the stimuli to take place before selective attention determine further processing. Kahneman (1973) proposed a theory of a limited capacity attention system, to explain selective attention. Since there is a capacity limit in short-term memory, once the items in the stimuli display have been processed to the point of recognition, the item(s) that are more potent receives further processing, i.e., rehearsal or recoding, while lesser item(s) are neglected and cease to receive further processing, i.e. are lost. The selective attention mechanism is thus theorized as providing the explanation for the higher recognition rates of the words that are more potent.

REFERENCES

Allport, G.W., & Vernon, P.E. A study of values. Boston: Houghton-Mifflin, 1931.

Anderson, J.A. Neural models with cognitive implications. In D. LaBerge & S.J. Samuels (Eds.), Basic Processes in reading: Perception and comprehension. Hillsdale, N.J.: Erlbaum, 1977.

Atkinson, R.C., & Shiffrin, R.M. Human memory: A proposed system and its control processes. In K.W. Spence & J.T. Spence (Eds.), The psychology of learning and motivation: Advances in research and theory (Vol. 2). New York: Academic Press, 1968.

Avant, L.L., & Lyman, P.L. Stimulus familarity modifies perceived duration in prerecognition visual processing. Journal of Experimental Psychology, 1975, 1, 205-213.

Baron, J. Mechanisms for pronouncing words: Use and acquisition. In D. LaBerge & S.J. Samuels (Eds.), Basic processes in reading: Perception and comprehension. Hillsdale, N.J.: Erlbaum, 1977.

Barron, R.W., & Pittenger, J.B. The effect of orthographic structure and lexical meaning on same-different judgments. Quarterly Journal of Experimental Psychology, 1974, 26, 566-581.

Beyer, W.H. (Ed.) CRC Handbook of mathematical sciences (5th Ed.), West Palm Beach, Fla,: CRC Press, 1978.

Bitterman, M.W., & Kniffin, C.W. Manifest anxiety and "perceptual defense". Journal of Abnormal and Social Psychology, 1953, 48, 248-253.

Bouma, H. Visual recognition of isolated lower-case letters. Vision Research, 1971, 11, 459-474.

Bouma, H. Visual interference in the parafoveal recognition of initial and final letters of words. Vision Research, 1973, 13, 767-782.

Bouma, H., & DeVoodg, A.H. On the control of eye saccades in reading. Vision Research, 1974, 14, 273-284.

Breitmeyer, B., & Ganz, L. Implications of sustained and transient channels for theories of visual pattern masking, saccadic suppression, and information processing. Psychological Review, 1976, 83, 1-36.

Broadbent, D.E. Perception and Communication. New York: Pergamon Press, 1958.

Brown, W.P. Conception and perceptual defense. British Journal of Psychology (Monograph Supplement), 1961, No. 35.

Bruner, J.S., & Postman, L. Emotional selectivity in perception and reaction. Journal of Personality, 1947, 16, 69-77.

Carroll, J.B., Davies, P., Richman, B. The American heritage word frequency book. New York: Houghton-Mifflin, 1971.

Chase, W.G. Elementary information processing. In W.K. Estes (Ed.), Handbook of learning and cognitive processes: Human information processing (Vol. 5). Hillsdale, N.J.: Erlbaum, 1978.

Collins, A.M., & Loftus, E.F. A spreading-activation theory of semantic processing. Psychological Review, 1975, 82, 407-428.

Coltheart, M. Visual information processing. In P.C. Dodwell (Ed.), New horizons in psychology 2. Hammondsworth: Penguin Books, 1972.

Coltheart, M. Iconic memory and visible persistence. Perception and Psychophysics, 1980, 27, 183-228.

Cumming, G.D. Eye movements and visual perception. In C.E. Carterette & M.P. Friedman (Eds.), Handbook of perception (Vol. 9). New York: Academic Press, 1978.

Deutsch, J.A., & Deutsch, D. Attention: Some theoretical considerations. Psychological Review, 1963, 70, 80-90.

Dick, A.O. Iconic memory and its relation to perceptual processing and other memory mechanisms. Perception and Psychophysics, 1974, 16, 575-596.

DiLollo, V., Lowe, D.G., & Scott, J.P. Backward masking and interference with the processing of brief visual displays. Journal of Experimental Psychology, 1974, 103, 934-940.

Ditchburn, R.W. Eye movements and visual perception. Oxford: Clarendon, 1973.

Dixon, N.F. Subliminal perception: The nature of a controversy. London: McGraw-Hill, 1971.

Dixon, NF., & Haider, M. Changes in the visual threshold as function of subception. Quarterly Journal of Experimental Psychology, 1961, 9, 229-235.

Dulany, D.E. Avoidance learning of perceptual defense and vigilance. Journal of Abnormal and Social Psychology, 1957, 55, 333-338.

Dunn-Rankin, P. The similarity of lowercase letters of the English alphabet. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 990-995.

Dunn-Rankin, P. The visual characteristics of words. Scientific American 1978, 238(1), 122-130.

Dunn-Rankin, P. Essentials of attitude measurement. Honolulu, HI: Dept. of Educational Psychology, University of Hawaii (no date). Mimeographed.

Dunn-Rankin, P., Abe-Sullivan, C., Gima, S., Hirata, G., & Loui, B.C. Word recognition in peripheral vision. Paper presented at Annual Meeting of Hawaii Educational Research Association. Honolulu, Hawaii, 1979.

Edelman, G. The use of cues in word recognition. In A basic research program in reading. Final Report, Project No. 639. Cornell University and U. S. Office of Education, 1963.

Erdelyi, M.H. A new look at the New Look: Perceptual defense and vigilance. Psychological Review, 1974, 81, 1-25.

Eriksen, C.W. Perception and personality. In J.M. Wepman & R. W. Heine (Eds.). Concepts of personality. Chicago: Aldine, 1963.

Eriksen, C.W. The use of a visual mask may seriously confound your experiment. Perception & Psychophysics, 1980, 28, 89-92.

Eriksen, C.W., & Schultz, D.W. Retinal locus and acuity in visual information processing. Bulletin of Psychonomic Society, 1977, 9, 81-84.

Erwin, D. The extraction of information from visual persistence. American Journal of Psychology, 1976, 89, 659-667.

Estes, W.K. Memory, perception and decision in letter identification. In R.L. Solso (Ed.), Information processing and cognition: The Loyola symposium. Hillsdale, N.J.: Erlbaum, 1975.

Estes, W.K. The information-processing approach to cognition: A confluence of metaphors and methods. In W.K. Estes (Ed.), Handbook of learning and cognitive process (Vol.5). Hillsdale, N.J.: Erlbaum, 1978.

Fisher, D., & Lefton, L. Peripheral information extraction: A developmental examination of reading processes. Journal of Experimental Child Psychology, 1976, 21, 77-93.

Foote, W.E., & Havens, L.L. Stimulus frequency: Determinant of perception or response? Psychonomic Science, 1965, 2, 153-154.

Forgus, L., & Melamed, L. Perception: A cognitive-stage approach. New York: McGraw-Hill, 1966.

Frankman, J.P., & Adams, J.A. Theories of vigilance. Psychological Bulletin, 1962, 59, 257-272.

Freeman, J.T. Set versus perceptual defense: A confirmation. Journal of Abnormal and Social Psychology, 1955, 51, 710-712.

Gaarder, K.R. Eye movements, vision and behavior. Washington, D.C.: Hemisphere, 1975.

Gerathewohl, S.J. Eye movements during radar operations. Journal of Aviation Medicine, 1952, 23, 597-607.

Gerritz, H.J.M., & Vendrik, A.J.H. The influence of stimulus movement on perception in parafoveal stabilized vision. Vision Research, 1974, 14, 175-180.

Geyer, J.J. Comprehensive and partial models related to the reading process. Reading Research Quarterly, 1972, 7, 543-587.

Geyer, J.J., & Kolers, P.A. Reading as information processing. In J. Voight (Ed.), Advances in librarianship (Vol. 4). New York: Academic Press, 1974.

Gibson, E.J., & Guinet, L. The perception of inflections in brief visual presentations of words. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 182-189.

Gibson, E. J., Bishop, C., Schiff, W., & Smith, J. Comparison of meaningfulness and pronounciability as grouping principles in the perception and retention of verbal material. Journal of Experimental Psychology, 1964, 67, 137-182.

Gibson, E.J., & Levin, H. The psychology of reading. Cambridge, Mass.: MIT Press, 1975.

Gibson, E.J., Osser, H., & Pick, A.D. A study in the development of grapheme-phoneme correspondences. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 142-146.

Gibson, E.J., Pick, A., Osser, H., & Hammond, M. The role of grapheme-phoneme correspondence in the perception of words. American Journal of Psychology, 1962, 75, 554-570.

Gima, S. A study of affective characteristics of words. Paper presented at Annual Meeting of Hawaii Educational Research Association. Honolulu, Hawaii, 1979.

Goldiamond,I., & Hawkins, W.F. Vexierversuch: The log relationship between word frequency and recognition in the absence of stimulus words. Journal of Experimental Psychology, 1958, 56, 457-463.

Gough, P.B. One second of reading. Visible Language, 1972, 6, 291-320.

Gould, J.D., & Schaffer, A. Eye movement pattern in scanning numeric displays. Perceptual and Motor Skills, 1965, 20, 521-535.

Haber, R.N. Information processing analyses of visual perception: An introduction. In R.N. Haber (Ed.), Information processing approaches to visual perception. New York: Holt, Rinehart, & Winston, 1969.

Haber, R.N. Control of eye movements during reading. In R.A. Monty & J.W. Senders (Eds.), Eye movements and psychological processes. Hillsdale, N.J.: Erlbaum, 1976.

Haber, R.N. Visual perception. In M.R. Rosenzweig & L.W. Porter (Eds.), Annual Review of Psychology. Palo Alto, Calif.: Annual Reviews, 1978.

Haber, R.N., & Hershenson, M. The psychology of visual perception. New York: Holt, Rinehart, & Winston, 1973.

Hasher, L., & Zacks, R.T. Automatic and effortful processes in memory. Journal of Experimental Psychology: General, 1979, 108, 356-388.

Havens, L.L., & Foote, W.E. The effect of competition on visual duration threshold and its independence of stimulus frequency. Journal of Experimental Psychology, 1963, 65, 6-11.

Hays, W.L. Statistics for psychologists. New York: Holt, Rinehart & Winston, 1963.

Henderson, L. A word superiority effect without orthographic assistance. Quarterly Journal of Experimental Psychology, 1974, 26, 301-311.

Henderson, L., & Chard, J. Semantic effects in visual word detection with visual simarity controlled. Perception and Psychophysics, 1978, 23, 290-298.

Hochberg, J. Components of literacy: Speculations and exploratory research. In H. Levin & J.P. Williams (Eds.), Basic studies on reading. New York: Basic Books, 1970.

Hochberg, J., & Brroks, V. Reading as an intentional behavior. In H. Singer & R. Ruddell (Eds.), Theoretical models and processes of reading. Newark, Del.: International Reading Association, 1970.

Holmes, D.L., Cohen, K.M., Haith, M.M., & Morrison, F.J. Peripheral visual processing. Perception and Psychophysics, 1977, 22, 571-577.

Howes, D.H., & Solomon, R. Visual duration thresholds as a function of word probability. Journal of Experimental Psychology, 1951, 41, 401-410.

Inglis, J. Abnormalities of motivation and "ego-functions". In H.J. Eysenck (Ed.), Handbook of abnormal psychology. New York: Basic Books, 1961.

Johnson, N.F. A pattern-unit model of word identification. In LaBerge, D.& S.J. Samuels (Eds.), Basic processes in reading. Hillsdale, N.J.: Erlbaum, 1977.

Johnson, N.F. On the function of letters in word identification: Some data and a preliminary model. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 17-29.

Kahneman, D. Methods, findings, and theory in studies of visual masking. Psychological Bulletin, 1968, 70, 404-425.

Kahneman, D. Attention and effort. Englewood Cliffs, N.J.: Prentice-Hall, 1973.

Kerr, J.L. Visual resolution in the periphery. Perception and Psychophysics, 1971, 9, 375-378.

King-Ellison, P., & Jenkins, J.J. The durational threshold of visual recognition as a function of word frequency. American Journal of Psychology, 1954, 67, 700-703.

Kleiman, G.M. Speech recoding in reading. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 323-339.

Klein, G.S., Spence, D., Holt, R., & Gourevitch, S. Cognition without awareness: Subliminal influences upon conscious thought. Journal of Abnormal and Social Psychology, 1958, 57, 255-266.

Kolers,P.A. Subliminal stimulation in problem solving. American Journal of Psychology, 1957, 70, 437-441.

Kolers, P.A. Three stages of reading. In H. Levin & J.P. Williams (Eds.), Basic studies in reading. New York: Basic Books, 1970.

Kolers, P.A. Buswell's discoveries. In R.A. Monty & J.W. Senders (Eds.), Eye movements and psychological processes. Hillsdale, N.J.: Erlbaum, 1976.

Kučera, H., & Francis, W.N. Computational analysis of present-day American English. Providence, R.I.: Brown University Press, 1970.

LaBerge, D., & Samuels, S.J. Toward a theory of automatic information processing in reading. Cognitive Psychology, 1974, 6, 293-323.

Lacy, O.W., Lewinger, N., & Adamson, J.F. Foreknowledge as a factor affecting perceptual defense and alertness. Journal of Experimental Psychology, 1953, 45, 169-174.

Lazarus, R.S., & McCleary, A.A. Autonomic discrimination without awareness: A study of subception. Psychological Review, 1951, 58, 113-122.

Liss, P. Does backward masking by visual noise stop stimulus processing? Perception and Psychophysics, 1968, 4, 328-330.

Low, F.N. Peripheral visual acuity. Archives of Ophthalmology, 1951, 45, 80-99

Malt, B., & Seamon, J. Peripheral and cognitive components of eye guidance in filled-space reading. Perception and Psychophysics, 1978, 23, 399-402.

Mandelbaum, J., & Sloan, L.L. Peripheral visual acuity. American Journal of Ophthalmology, 1947, 30, 581-588.

Manelis, L. The effect of meaningfulness in tachistoscopic word perception. Perception and Psychophysics, 1974, 16, 182-192.

Marchbanks, G., & Levin, H. Cues by which children recognize words. Journal of Educational Psychology, 1965, 56, 57-61.

Massaro, D.W. Experimental psychology and information processing. Chicago: Rand, McNally, 1975. (a)

Massaro, D.W. Primary and secondary recognition in reading. In D.W. Massaro (Ed.), Understanding language: An information processing analysis of speech perception, reading and psycholinguistics. New York: Academic Press, 1975. (b)

McConkie, G.W., & Rayner, K. The span of the effective stimulus during fixations in reading. Paper presented at the American Educational Research Association meeting. New Orleans, 1973.

McGinnies, E. Emotionality and perceptual defense. Psychological Review, 1949, 56, 244-251.

Meyer, D.E., Schvaneveldt, R.W., & Ruddy, M. Loci of contextual effects on visual word-recognition. In P.M.A. Rabbit & S. Dornic (Eds.), Attention and performance V. London: Adademic Press, 1975.

Miller, G.A., Bruner, J., & Postman, L. Familiarity of letter sequences and tachistoscopic identification. Journal of General Psychology, 1954, 50, 129-139.

Minard, J.G. Response-bias interpretation of "perceptual defense". Psychological Review, 1965, 72, 74-88.

Mishkin, M., & Forgays, D.G. Word recognition as a function of retinal locus. Journal of Experimental Psychology, 1952, 43, 43-48.

Moray, N. Attention: Selective processes in vision and hearing. London: Hutchinson, 1969.

Neisser, U. Cognitive Psychology. New York: Appleton-Century-Crofts, 1967.

Nelson, D.L., Peebles, J., & Pancotto, F. Phonetic similarity as opposed to information structure as a determinant of word encoding. Journal of Experimental Psychology, 1970, 86, 117-119.

Newton, K. A note on visual recognition thresholds. Journal of Abnormal and Social Psychology, 1955, 51, 709-710.

Norman, D.A. Memory and attention: An introduction to human information processing. New York: Wiley, 1968.

Novick, N. Parallel processing in a non-word classification task. Journal of Experimental Psychology, 1974, 102, 1015-1020.

Osgood, C.E., & Hoosain, R. Salience of the word unit as a unit in the perception of language. Perception and Psychophysics, 1974, 15, 168-192.

Osgood, C.E., Suci, G.J., & Tannenbaum, P.H. The measurement of meaning. Urbana, Illinois: University of Illinois Press, 1957.

Pierce, J.R. Determinants of threshold for form. Psychological Bulletin, 1963, 60, 391-407.

Posner, M.I., & Snyder, C.R.R. Attention and cognitive control. In R.L. Solso (Ed.), Information processing and cognition: The Loyola symposiums. Hillsdale, N.J.: Erlbaum, 1975.

Postman, L., Bronson, W.C., & Gropper, G.L. Is there a mechanism of perceptual defense? Journal of Abnormal and Social Psychology, 1953, 48, 215-225.

Postman, L., Bruner, J.. & McGinnies, E. Personal values as selective factors in perception. Journal of Abnormal and Social Psychology, 1948, 43, 142-155.

Postman, L,& Rosenzweig, M.R. Perceptual recognition of words. Journal of speech and Hearing Disorders, 1957, 22, 245-253.

Postman, L., & Schneider, B. Personal values, visual recognition and recall. Psychological Review, 1951, 58, 271-284.

Rayner, K. The perceptual span and peripheral cues in reading. Cognitive Psychology, 1975, 7, 65-81.

Rayner, K. Visual attention in reading: Eye movements reflect cognitive processes. Memory & Cognition, 1977, 5, 443-448.

Reicher, G.M. Perceptual recognition as a function of meaningfulness of the stimulus material. Journal of Experimental Psychology, 1969, 81, 275-280.

Riegel, K,F., & Riegel, R.M. Prediction of word-recognition thresholds on the basis of stimulus-parameters. Language and Speech, 1961, 4, 157-170.

Rumelhart, D.E., & Siple, P. Process of recognizing tachistoscopically presented words. Psychological Review, 1974, 81, 99-118.

Samuels, I. Reticular mechanisms and behavior. Psychological Bulletin, 1959, 56, 1-25.

Schiepers, C.W. Global attributes in visual word recognition:II. The combination of word length. Vision Research, 1976, 16, 1445-1454.

Schiffman, H.R. Some components of sensation and perception for the reading process. Reading Research Quarterly, 1972, 7, 588-612.

Schlosberg, H. Time relations in serial visual perception. Canadian Psychologist, 1965, 69, 161-172.

Schvaneveldt, R.W., & Meyer, D.E. Retrieval and companion processes in semantic memory. In S. Kornblum (Ed.), Attention and performance IV. New York: Academic Press, 1973.

Shiffrin, R.M. The locus and role of attention in memory systems. In P.M.A. Rabbitt & S. Dornic (Eds.), Attention and performance V. New York: Academic Press, 1975.

Smith, F. Understanding reading. New York: Holt, Rinehart & Winston, 1971.

Solomon, R.L., & Postman, L. Frequency of usage as a determinant of recognition thresholds of words. Journal of Experimental Psychology, 1952, 43, 195-201.

Somekh, D.E., & Wilding, J.M. Perception without awareness in dichoptic viewing situation. British Journal of Psychology, 1973, 64, 339-349.

Sperling, G. The information available in brief visual presentations. Psychological Monographs, 1960, 74, (11, Whole No. 498).

Sperling, G. A model for visual memory tasks. Human Factors, 1963, 5, 19-31.

Sperling, G. Successive approximations to a model for short term memory. Acta Psychologica, 1967, 27, 285-292.

Spoehr, K.T., & Smith, E.E. The role of syllables in perceptual processing. Cognitive Psychology, 1973, 5, 71-89.

Spragins, A.B., Lefton, L.A., & Fisher, D. F. Eye movements while reading and searching spatially transformed text: A developmental examination. Memory and Cognition, 1976, 4, 36-42.

Stevens, A.L., & Rumelhart, D.E. Errors in reading: Analysis using an aug mented netword model of grammar. In D.A. Norman, D.E. Rumelhart and the LNR Research Group, Explorations in cognition. San Francisco: Freeman, 1975.

Theios, J., & Muise, G. The word identification process in reading. In N. J. Castellan D. Pisoni (Eds.), Cognitive Theory (Vol. 2). Hillsdale, N.J.: Erlbaum, 1977.

Thompson, R.F., & Bettinger, L.A. Neural substrates of attention. In D. Mostofsky (Ed.), Attention: Contemporary theory and analysis. New York: Appleton-Century-Crofts, 1970.

Thorndike, E.L., & Lorge, I. The teachers' wordbook of 30,000 words. New York: Bureau of Publications, Teachers College, Columbia University, 1944.

Tinker, M.A. Prolonged reading tasks in visual research. Journal of Applied Psychology, 1955, 39, 444-446.

Tinker, M.A. Recent studies of eye movements in reading. Psychological Bulletin, 1958, 55, 215-231.

Tinker, M.A. Bases for effective reading. Minneapolis: University of Minnesota Press, 1965.

Treisman, A.M. Verbal cues, language and meaning selective attention. American Journal of Psychology, 1964, 77, 206-219.

Turvey, M.T. On peripheral and central processes in vision: Inferences from an information-processing analysis of masking with patterned stimuli. Psychological Review, 1973, 80, 1-52.

Underwood, B.J. Temporal codes for memories: Issues and problems. Hillsdale, N.J.: Erlbaum, 1977.

Waugh, N.C., & Norman, D.A. Primary memory. Psychological Review, 1965, 72, 89-105.

Weber, R-M. First graders' use of grammatical context in reading. In H. Levin & J.P. Williams (Eds.), Basic Studies in reading. New York: Basic Books, 1970.

Weiner, M. Word frequency or motivation in perceptual defense. Journal of Abnormal and Social Psychology, 1955, 51, 214-218.

Wheeler, D.D. Processes in word recognition. Cognitive Psychology, 1970, 1, 59-85.

Wickens, D.D. Characteristics of word encoding. In A.W. Melton & E. Martin (Eds.), Coding processes in human memory. Washington, D.C.: Winston, 1972.

Winnick, W.A., & Kressel, K. Tachistoscopic recognition thresholds, paired-associate learning, and free recall as a function of abstractness-concreteness and word frequency. Journal of Experimental Psychology, 1965, 70, 163-168.

Worden, F.G. Attention and auditory eletrophysiology. In E. Stellar & J.M. Sprague (Eds.), Progress in physiological psychology (Vol. 1). New York: Academic Press, 1966.

Zinchenko, V.P., & Vergiles, N. Yu. [Formation of visual images] (B. Haigh, Trans). New York: Consultants Bureau, 1972.

REFERENCE NOTE

1. Uttal, W.R. Personal Communication. Sept. 2, 1980.

LIST OF TABLES

		Page
I.	Stimuli Sets in Treatment Variable	38
II.a.	Descriptive Statistics for Sample I	43
II.b.	Descriptive Statistics for Sample II	43
III.	Two-Way Analysis of Variance Table for Sample I	44
IV.	Two-Way Analysis of Variance Table for Sample II	45
V.a.	Regression Analysis for Sample I	47
V.b.	Regression Analysis for Sample II	47
VI.a.	Hit Rates for Sample I	49
VI.b.	Hit Rates for Sample II	49